GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT INITIATION

Date: June 13, 1977

Project Title: Evaluation of Heat Exchangers for Solar Energy Applications

Project No: A-2002

Project Director: Mr. A. T. Sales

Sponsor: Larkin Coils, Inc.

Agreement Period: From ~~6/13/77~~ 5/23/77 Until 9/12/77

Type Agreement: Std. Ind. Res. Agree. dtd. 5/13/77

Amount: $4,114

Reports Required: Final Report

Sponsor Contact Person (s):

Technical Matters

Contractual Matters (thru OCA)

Mr. W. K. Sim, President or
Mr. Frank Denson
Larkin Coils, Inc.
P.O. Box 1699
Atlanta, GA 30301

Defense Priority Rating: None

Assigned to: Applied Sciences Laboratory (School/Laboratory)

COPIES TO:

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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 11/10/78

Project Title: Evaluation of Heat Exchangers for Solar Energy Applications

Project No: A-2002

Project Director: Mr. A. T. Sales

Sponsor: Larkin Coils, Inc.

Effective Termination Date: 5/31/78

Clearance of Accounting Charges: 5/31/78

Grant/Contract Closeout Actions Remaining:

- X Final Invoice ~~and Closing Documents~~ XXXXXXXXXXXXXXX
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other ________

Assigned to: Applied Sciences Laboratory (School/Laboratory)

COPIES TO:

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CA-4 (3/76)

A-2002

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 29, 1978

Larkin Coils, Inc.
P. O. Box 1699
Atlanta, Georgia 30301

Attention: Mr. W. K. Sims, President

Subject: Evaluation of Heat Exchangers for Solar Energy Applications-
Phase II

Gentlemen:

Tests have been completed on the solar collector panels fabricated by the Engineering Experiment Station; the collectors utilized heat exchangers designed and provided by Larkin Coils, Inc. The collectors were tested in accordance with the procedures outlined in the ASHRAE Standard 93-77. This report gives the results of the current evaluation and compares the results with those obtained in Phase I. General observations made during collector design, fabrication, and evaluation are also summarized.

The aluminum fins on the backside of each heat exchanger were rolled flat; this section of the fins was now parallel with the copper tubing. The frontside of each heat exchanger was spray painted with an absorber coating of Rust-Oleum 427 Bar-B-Q Black paint. The heat exchangers were exposed to six or more hours of insolation. This exposure cured the paint and evaporated volatiles from the absorber coating.

The collector frame was modified to better seal the glazing. Aluminum covers were fabricated which would not be warped by water, would better distribute sealing pressure, and could be sealed easily. All seams on the collectors were sealed with a clear Dow Corning Silicone RTV sealant.

The collectors were placed on the test racks at an angle which would place the collector perpendicular to the sun at solar noon. For an aging period, the collectors were not connected to the water for more than fifteen days. Water condensation on the underside of the glazing was a problem during rainy days or periods of high humidity. Several clear days with high insolation levels was sufficient to dry the interior of the collectors. After the aging, the inlet and outlet areas were sealed with silicone sealant. The collectors were tested over a four hour period on each of two days with the test period beginning approximately two hours before solar noon and ending approximately two hours after solar noon. Ambient temperatures, inlet temperature and exit temperature were measured each minute and averaged over each fifteen minute test period. The solar insolation at the collector angle and on a horizontal plane were measured and continuously and automatically integrated over each fifteen minute period.

The following observations were made during the heat exchanger evaluations:

1. At end of the evaluation of heat exchanger "F", the pump was cut off. The temperature of the collector climbed to 236°F causing a failure of solder joints at the top and bottom of the collector. Steam was visible at the failures.

2. Although 236°F was reached in this one instance, the average maximum temperature was about 160°F. Several factors could be responsible for this ceiling temperature: the maximum absorbing value of the paint used for a selective coating could have been obtained, more insolation might be required to reduce heat losses, or the total cross-sectional area of the copper tubes in the absorber might not be maximized.

3. To fully evaluate the effect of 3/8-inch tubing in the absorber, the number of tubes might be reduced from 26 to 10 which would increase the Reynolds number.

4. The value of the side channels on the heat exchangers is questionable. These channels do not add to the structural stability of the collector since the absorber could actually be on the insulation backing and the end channels could lie attached permanently to the collector frame. The advantage of the side channels is for the heat exchanger handling during collector fabrication.

5. For ease of collector fabrication, when both side and end channels are to be used, the assembly of the collector would have been easier if the channel configuration had been "L" or "Z" shaped.

6. The evaluation of heat exchanger "F" was questionable, and a second test was run. Cloud cover after solar noon appeared to increase; also the movement of the clouds decreased. This affected the insolation values, and it was decided to re-evaluate the collector. As can be seen, a higher performance curve was obtained on a clear day.

7. A double glaze on the collector ("F") did not result in an appreciable difference from a single glaze collector ("C"). The higher cost of a double glaze, about four times the cost of single glaze, and the possible limitations of the selective coating, apparently do not justify this added expense.

It should be noted that the solar thermal performance curves are not usually a straight line, but because of the many data points and the scatter of this data, a least-square fit of the data provides a best-fit straight-line curve. In practice, there would probably be a curve downward for higher values of "P".

Respectfully submitted,

A. T. Sales
Research Engineer
Solar Energy
Materials & Technology
Division

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TABLE I

HEAT EXCHANGER DESIGN AND EVALUATION CONDITIONS

Collector[a]	Number of Copper Tubes	Diameter of Tubes (inch)	Total Area of Tubes (in^2)	Number of Covers	Transfer Fluid	Flow Rate (gpm)	Sky Conditions	Performance Equation c.
A	22	1/2	4.320	1	50-50[b]	2.25	Scattered Clouds	$\eta = 36.0 - 61.9 P$
B	11	1/2	2.160	1	50-50[b]	2.25	Scattered Clouds	$\eta = 84.0 - 138.1 P$
C	11	1/2	2.160	1	50-50[b]	0.53	Scattered Clouds	$\eta = 81.7 - 98.0 P$
D	7	1/2	1.374	1	Water	0.50	Clear	$\eta \quad 72.7 - 178.5 P$
E	26	3/8	2.872	1	Water	0.50	Clear	$\eta = 64.3 - 130.5 P$
F	11	1/2	2.160	1	Water	0.50	Scattered Clouds	$\eta = 75.7 - 154.0 P$
F2	11	1/2	2.160	2	Water	0.50	Clear	$\eta = 75.6 - 71.7 P$

a. Collector area: 15.9 square feet
b. 50% water - 50% Prestone II
c. η = Per Cent Efficiency

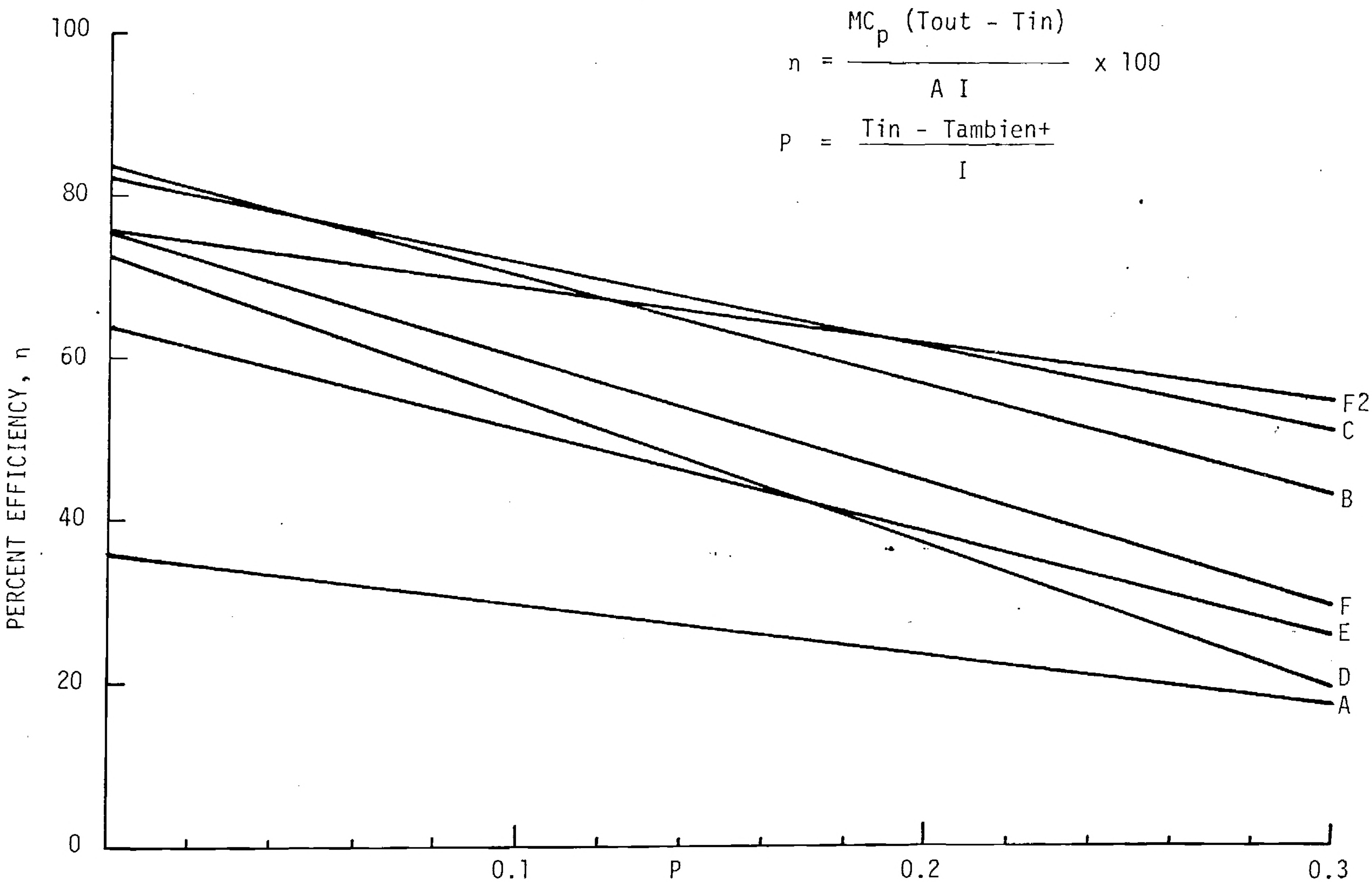

Figure I. Solar Thermal Performance Curves for Larkin Coils, Inc.